Lightweight SiC-Composite Optics for Laser Applications

Witold Kowbel
MER Corporation

Statement of the problem:

- Monolithic SiC mirror technology (α-SiC, β-SiC, siliconized SiC) suffer from poor fracture toughness. They exhibit intrinsic size limitation.

- Single crystal Si mirrors, very brittle, metallic mirrors – high CTE.

Objective:

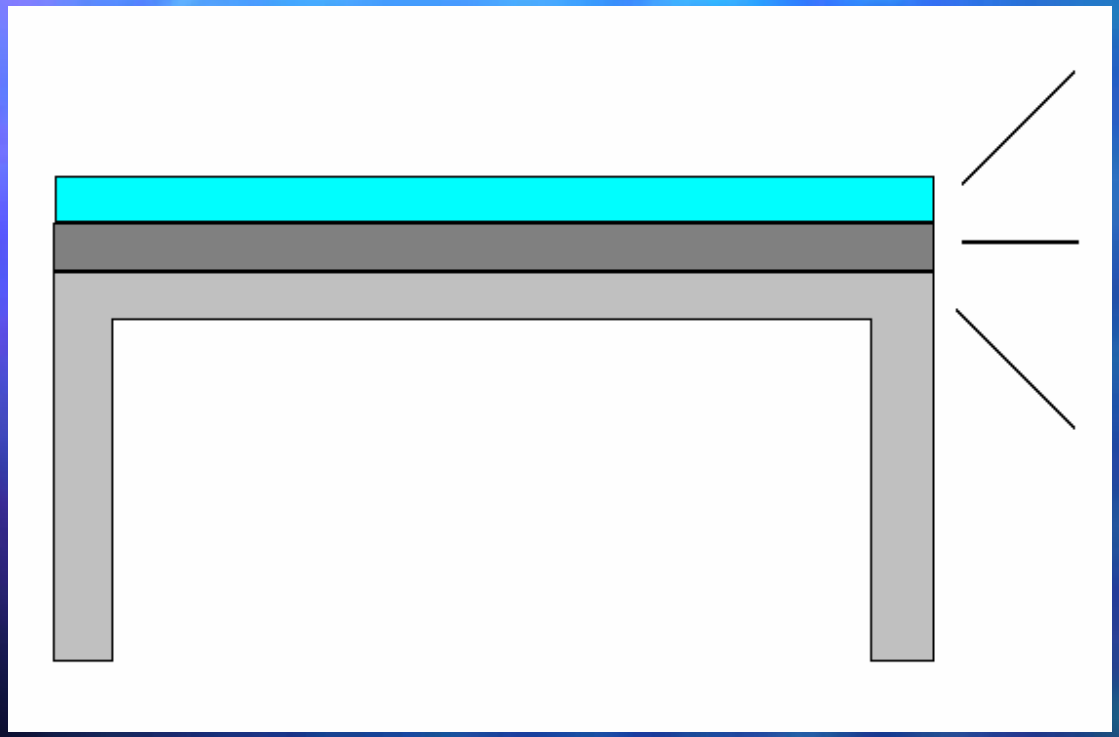
- Demonstrate the use of SiC-based composite technology for laser applications

Strategy

1. Combining expertise in materials, composite , optical fabrication and testing to meet the need of industry.

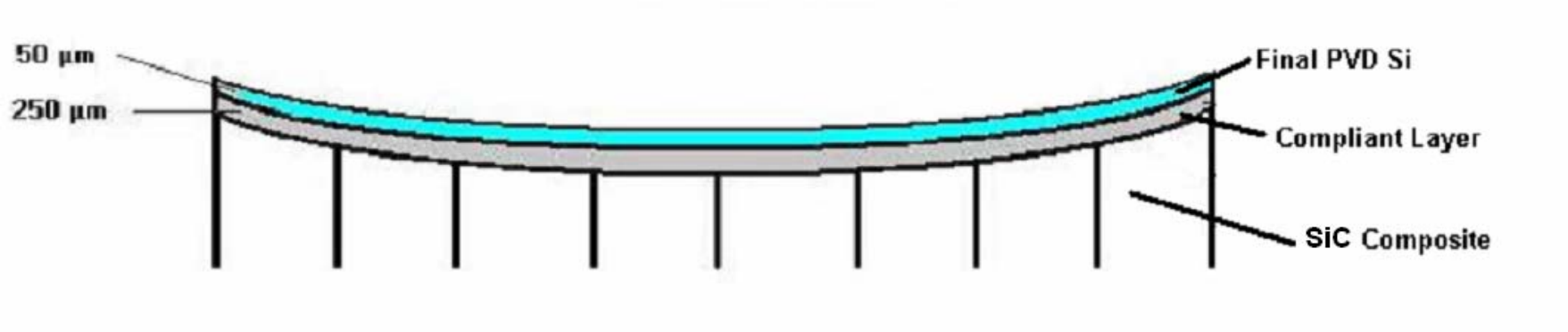
2. Grouping existing technology together to shorten production time.

Small SiC composite Laser optics



- CVD or PVD Si
- Compliant layer
- SiC composite

MER 1.5 meter Mirrors (chemical laser)



Functionality of Different Mirror Constituents:

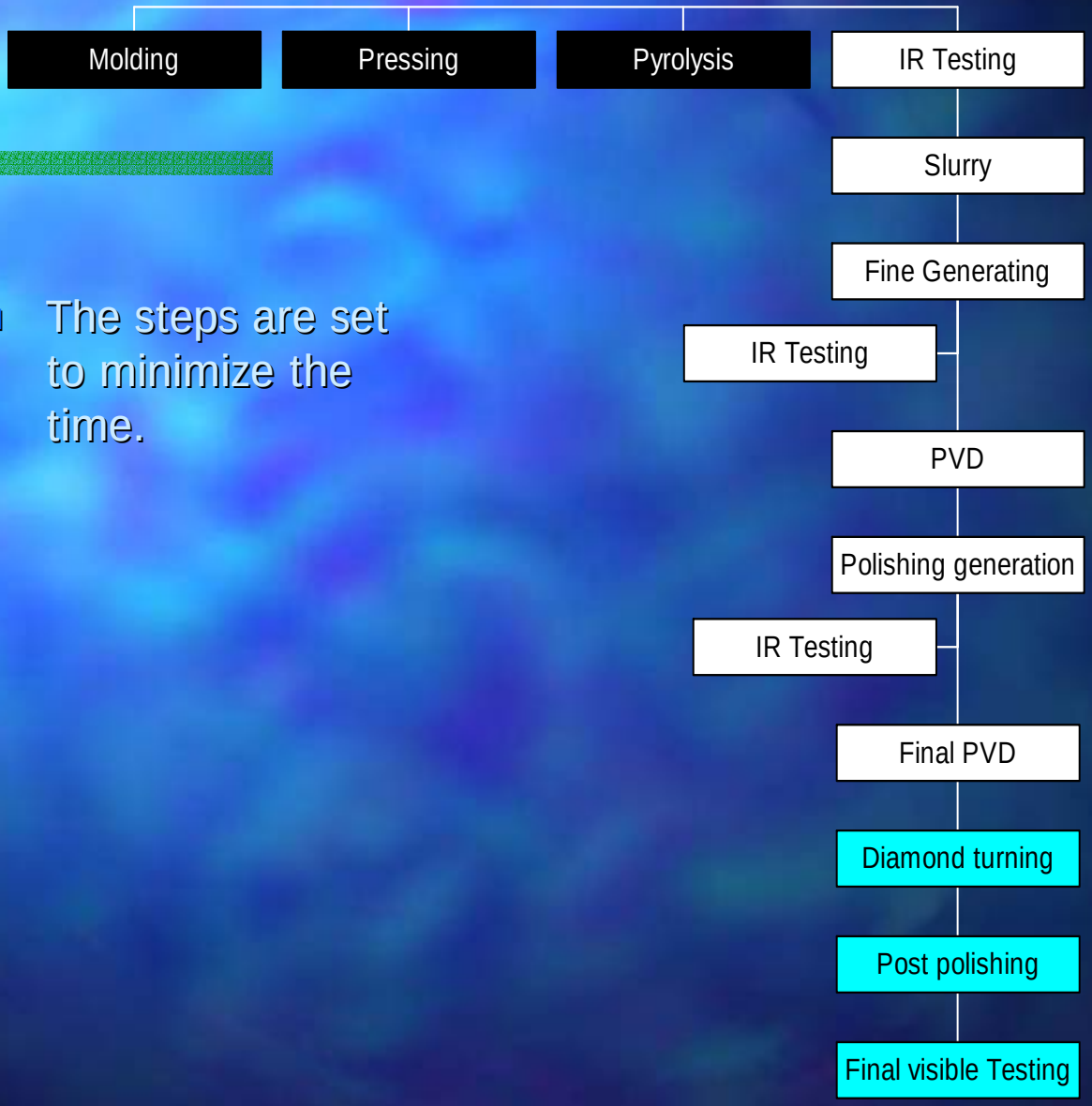
Composite honeycomb – very high stiffness, designed for the first eigen frequency, highly non-brittle, low density, CTE matched to Si, isotropic properties.

- Slurry – tailored modulus eliminates the nano crazing (elastic modulus relief) and print-through.

- Si diamond turn able optical surface.

Process

Steps:

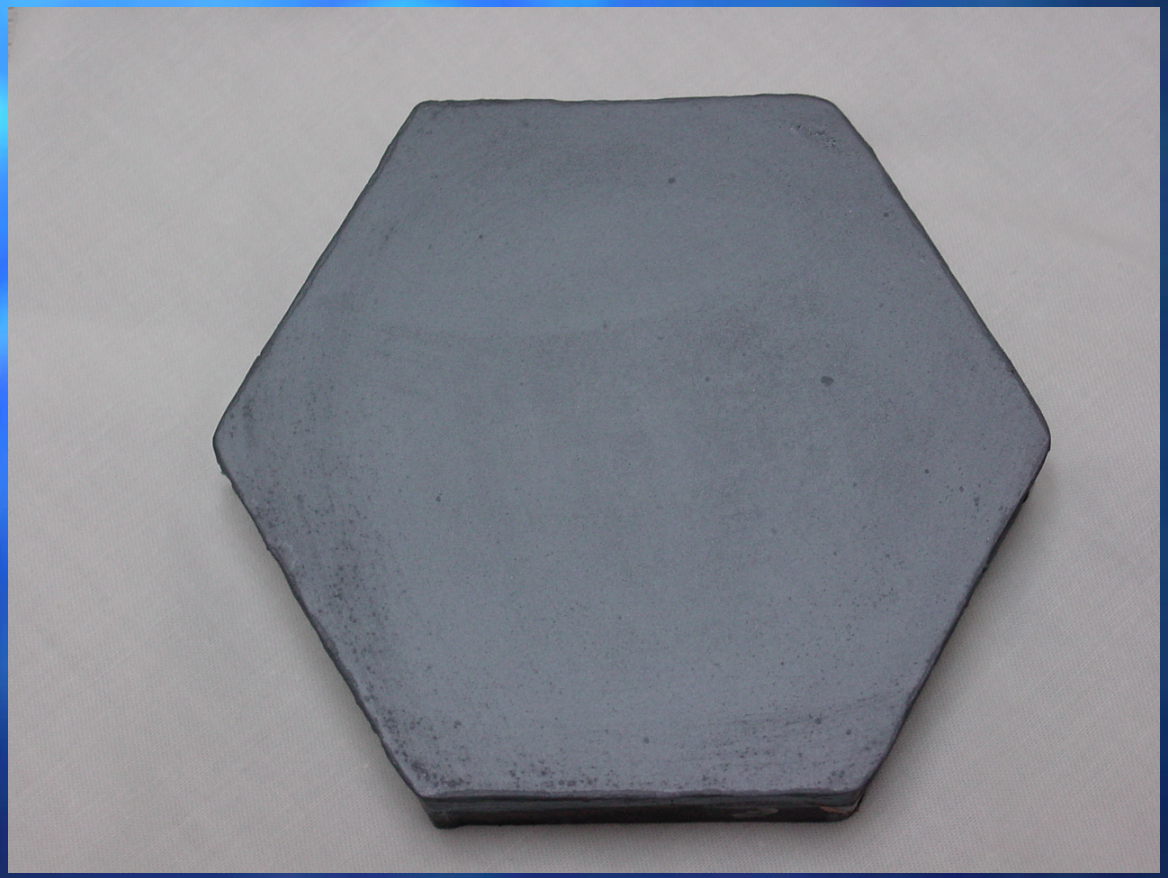


- The steps are set to minimize the time.

Risk Mitigation Strategy:

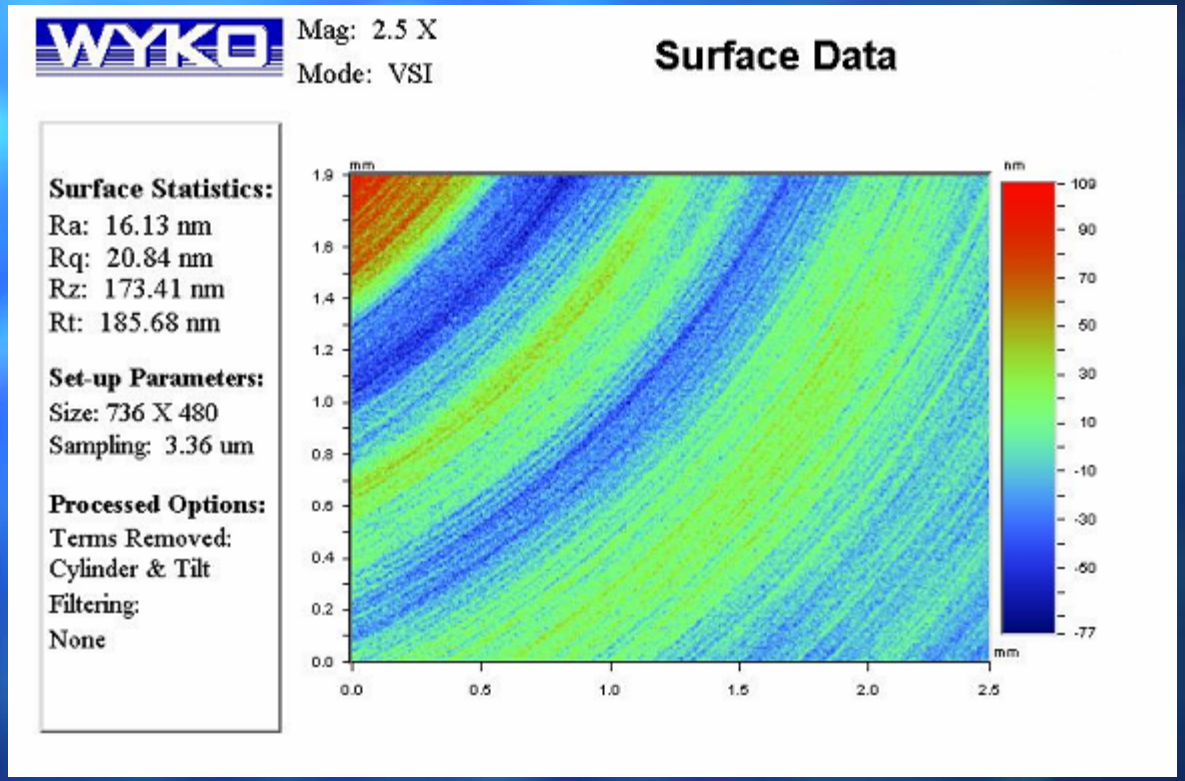
- 4”
- Establish adherent Si coatings
- Establish thermal stability under laser conditions
- Establish no “print-through”
- 18”
- Establish diamond turning on the Si coating, representative of an 18 inch mirror.
- Establish the ability to figure the mirror in a cost-effective fashion.

. 4” Optics Coated with about 70 μm PVD-Si.



Diamond Turned 4” Optics.

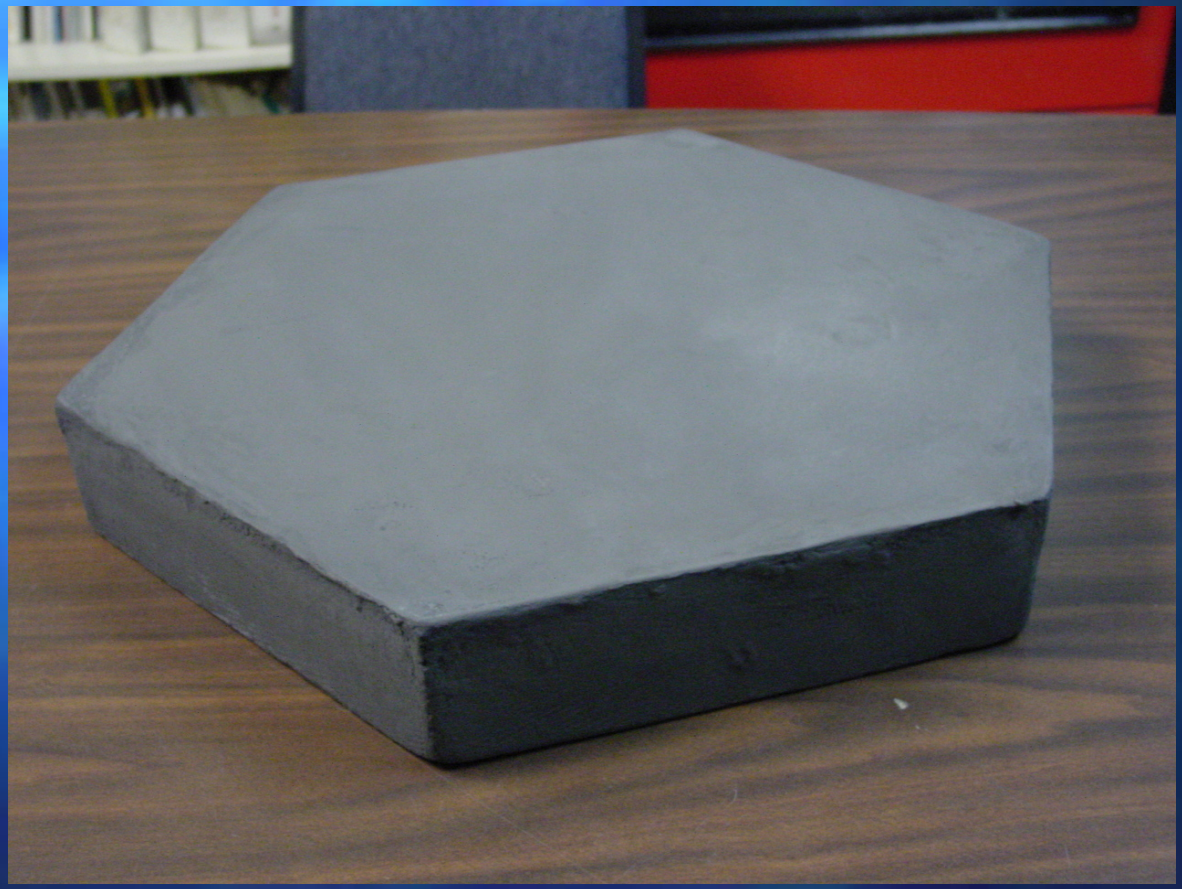
Micro-roughness of Diamond turned Si-mirror



- A 16 nm roughness was achieved off a raw diamond turn mirror.

18” Flat composite structures

Surface of 18” Optics With SiC-slurry.



Laser testing

- 4” SiC-optics with MLD coatings